Product User Manual

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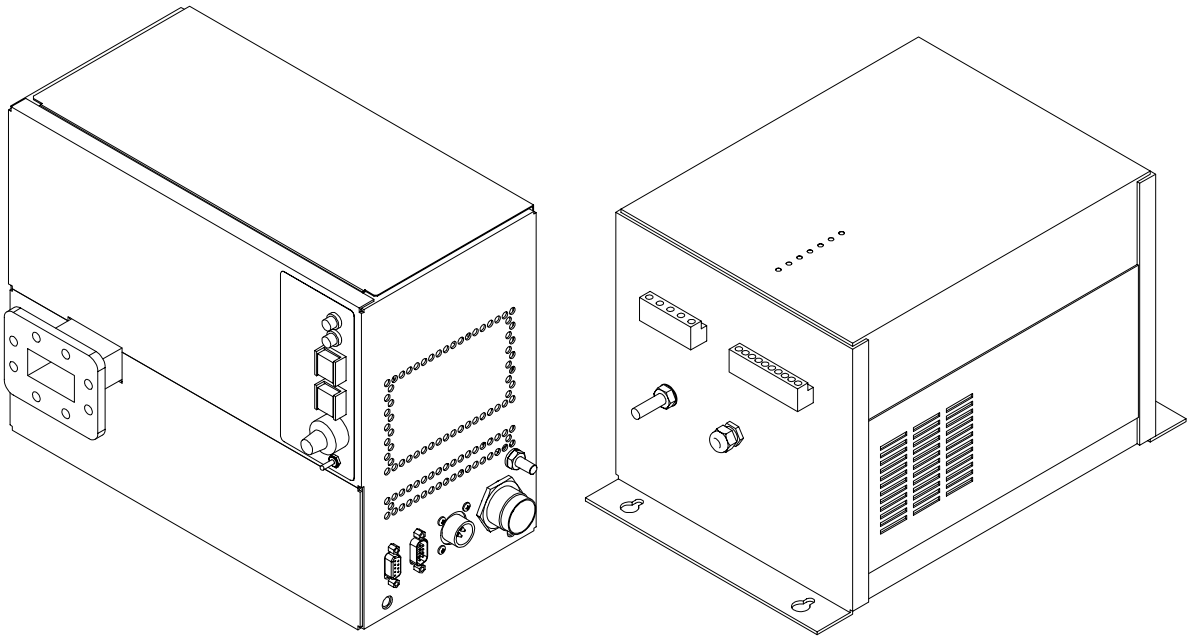
Model GA4306
700W Microwave Generator, 5.8 GHz



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1	PROTOTYPE RELEASE	13JAN04	JFG
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WARRANTY

Products manufactured and sold by Gerling Applied Engineering, Inc. ("GAE") are warranted to be free of defects in materials and workmanship under normal use and service for a period of twelve (12) months from the date of original shipment. GAE's obligation under this warranty is limited to repairing or replacing, at GAE's option, all non-consumable component parts. Consumable parts are specifically excluded from this warranty and may include, but are not be limited to, magnetrons, fuses, lamps, seals, o-rings, v-belts, and fluids. All warranty repairs are to be done at GAE's facility or as otherwise authorized by GAE. All shipping charges for warranty repair or replacement are the purchaser's responsibility unless otherwise agreed to by GAE.

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DOCUMENT CONVENTIONS

NOTE: *Means the reader should take note. Notes contain helpful information, suggestions, or references to other sections, chapters, or documents.*

CAUTION: *Means the reader should be careful. You are doing something that might result in equipment damage or loss of data.*

WARNING: *Means danger. A situation exists that could cause bodily injury or death. All personnel must be aware of the hazards involved with high voltage electrical circuitry and high power microwave devices.*

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WARNING

All microwave generators manufactured by GAE, Inc. are capable of producing a microwave field that is potentially hazardous to operating personnel. They must never be connected or operated in a manner that allows a field in excess of 10 milliwatts per square centimeter to be generated in an area accessible to operating personnel. Contact GAE, Inc. for technical support prior to installation and/or operation of these units if there is any question or concern about microwave leakage.

All waveguide flange and electrical cable connections throughout the system must be secure prior to operation. Never operate the microwave generator without a properly rated absorbing load attached. To ensure safe operation and prevent microwave leakage, the equipment must be periodically inspected and maintained as required or recommended.

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EQUIPMENT DESCRIPTION

The model GA4306 Microwave Generator is a completely integrated system designed for high performance yet economical delivery of 5.8 GHz microwave power. Consisting of separate magnetron head and switch mode power supply modules, this user-friendly system is easily configured for laboratory use or integrated into production equipment with minimal design effort. All control functionality is located conveniently near the work area as well as available remotely for automated processing.

The magnetron head is designed to comply with safety regulations when used in the laboratory or as part of an industrial process system. The power supply must be installed inside a compliant enclosure to meet safety regulations. Both units are housed of brushed metallic enclosures for a striking appearance and rugged durability. Convenient mounting holes facilitate equipment integration and installation.

Safety and serviceability were primary considerations in design of the GA4306 system. Removal and replacement of the internal magnetron can be accomplished in less than ten minutes using standard tools. In addition, captive hardware is used for all fasteners relating to magnetron removal, thus preventing loss or misuse of loose hardware.

The complete system includes mating connectors and a standardized 10 ft. cable harness for connecting between the magnetron head and power supply (alternate lengths may be specified by customer). Optionally, the interconnect cables and/ or connector set may be ordered separately. Contact GAE for more detailed information on these and other available options and custom configurations.

General Specifications

Output Power (max)	700 Watts
Frequency	5.8 GHz +/- 30 MHz
Magnetron	Panasonic M5801, GAE p/n 911405
Output Waveguide	WR159 (RG344/U)
Output Flange	CPR159 (UG1731/U)
Cooling	Forced air by internal fans
Input Line Power	180-265 VAC, 50/60 Hz, single-phase, 12 A max. (at 230 VAC)
Remote Controls	Mw Enable (8-30 VDC input) Mw Adjust (0-6.5 VDC input)

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	Anode Current Reference (1 VDC = 100 mA) System Ready Indicator Interlock Loop
Interlocks	Access cover; Magnetron over-temperature; Cooling Fans

Mating Connectors

(supplied with interconnect cable set)

High Voltage	AMP # 863022-1 (includes shell, contacts, strain relief)
Filament/Fan Power	Shell: AMP # 206060-1 Contact: AMP # 66360-4 Cable Clamp: AMP # 206062-1
Control Input/Output	Shell: AMP # 205203-1 Contact: AMP # 66569-3 Cable Clamp: AMP # 748676-1
Remote Control	Shell: AMP # 205204-1 Contact: AMP # 66570-3 Cable Clamp: AMP # 748676-1

Components Supplied

Item Description	GAE Part Number
Magnetron Head	GA4007 (includes mating remote control connector)
Power Supply	911393
Interconnect Cable Set	911492
Product User Manual	930038

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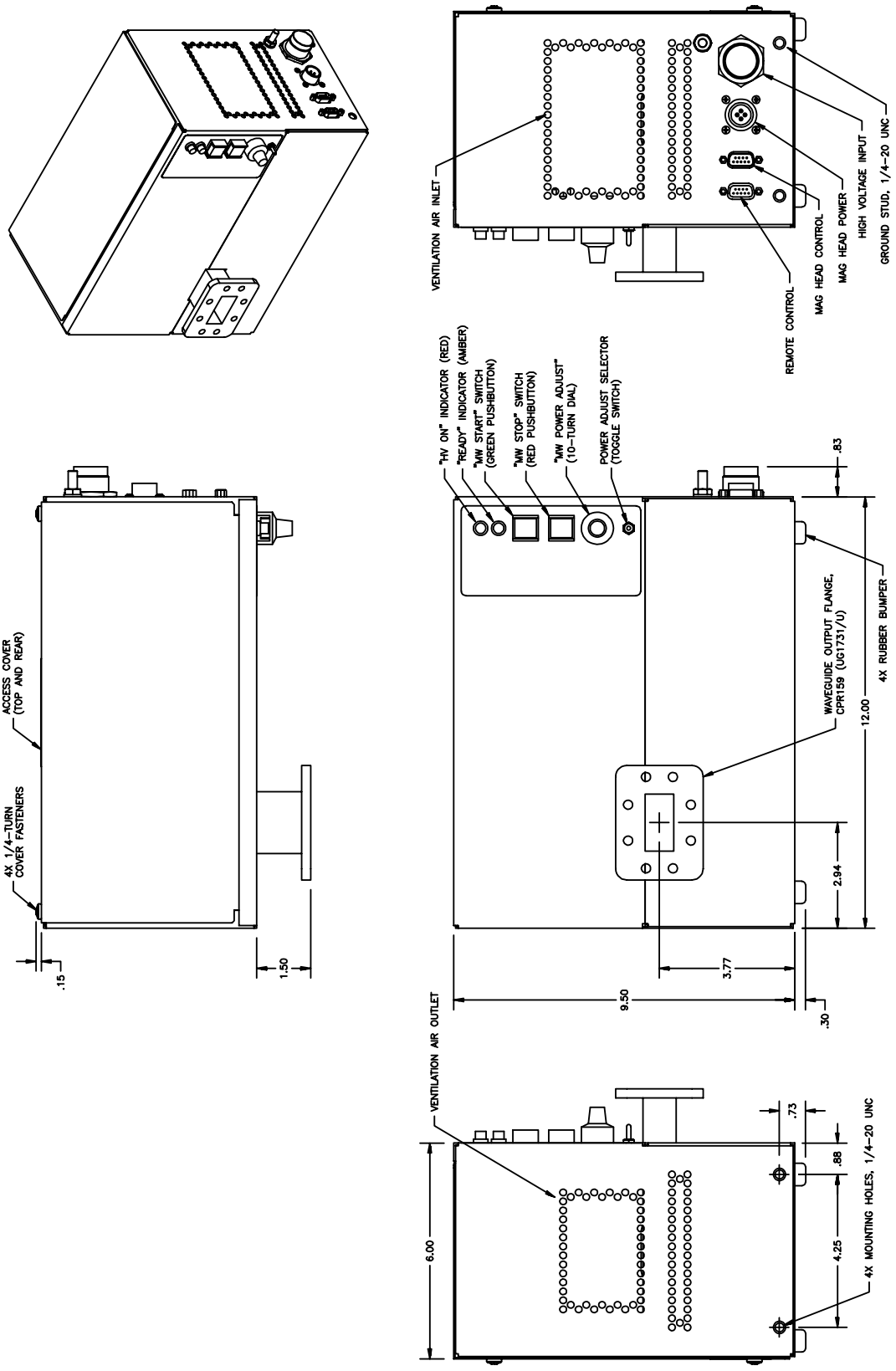
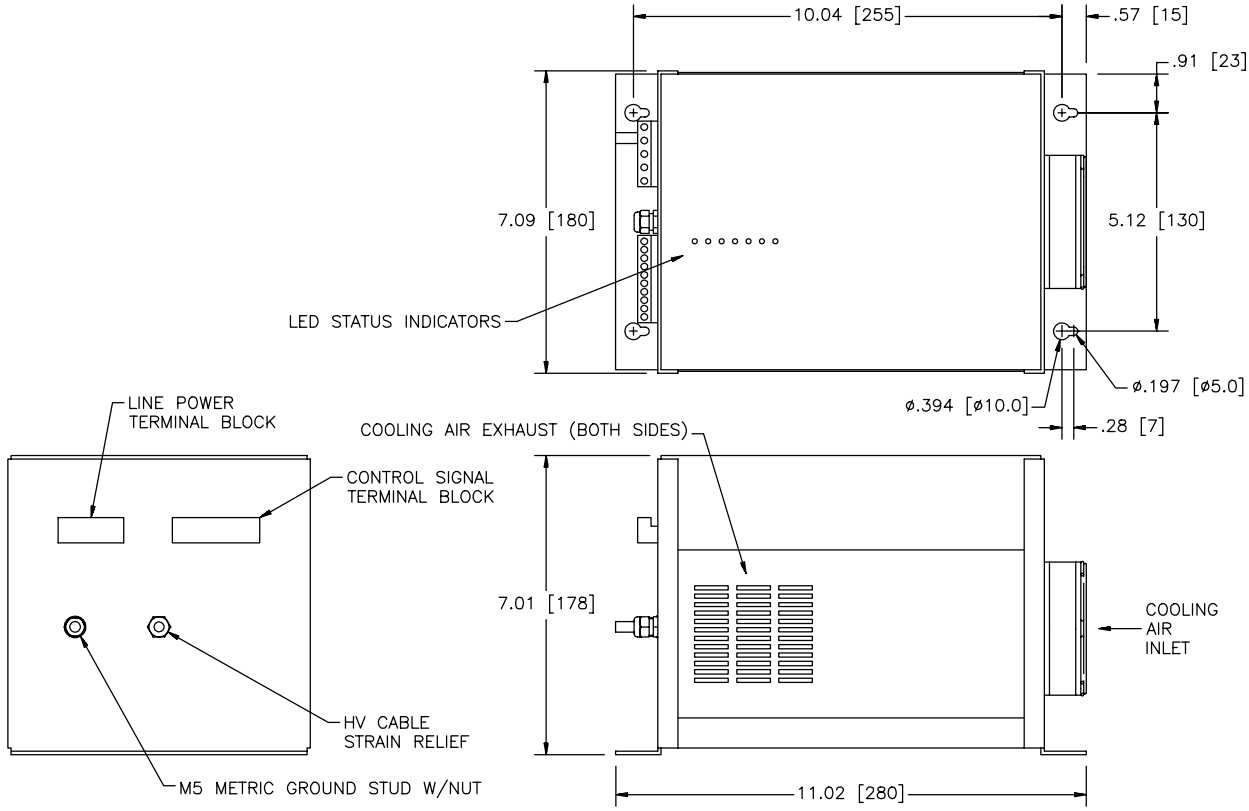
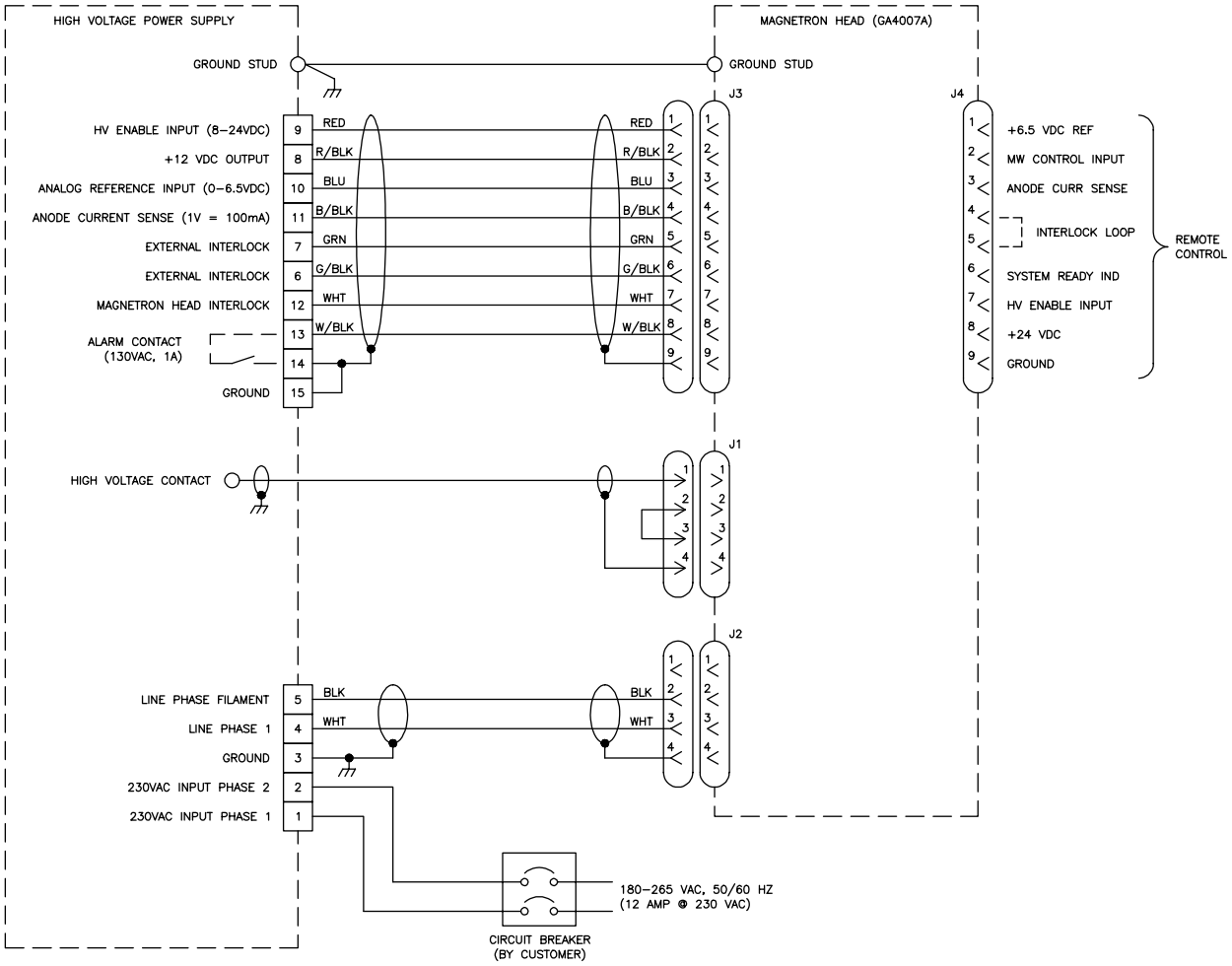
Magnetron Head Outline Drawing



Power Supply Outline Drawing



Schematic Diagram



INSTALLATION

Preliminary Inspection

Upon arrival at the installation site the GA4306 system components should be thoroughly inspected for damage or wear caused during shipping. Any visible damage to the packaging material or the equipment itself should be noted and reported immediately to the shipping company in accordance with standard claims procedures.

Magnetron Head Installation

The magnetron head is designed for use in a clean, dry environment such as a laboratory or cleanroom. Adequate clearance must be provided at both ends of the enclosure to allow ventilation air to flow freely. The magnetron head can be installed in any orientation that is convenient for connection to the waveguide components.

Mounting holes are provided at both ends of the enclosure for securing the magnetron head. These hole are tapped for ¼-20UNC bolts and allow up to ½" of insertion depth.

Power Supply Installation

The power supply is designed for installation inside another electrical equipment enclosure having adequate safety shielding for protection from the exposed electrical connections. The enclosure should provide adequate clearance at the sides and rear of the power supply to allow ventilation air to flow freely. The power supply can installed on any vertical or horizontal surface in any orientation. Brackets with keyed mounting holes are provided for convenience.

Waveguide Configuration

The GA4306 generator system can be connected to and used with any common waveguide component having a compatible flange (see below). Mounting can be in any convenient position and orientation. Ideally, the magnetron head should be connected directly to an isolator (or 3-port circulator and dummy load) to ensure adequate protection of the magnetron from reverse power. Figure 1 illustrates a typical waveguide configuration.

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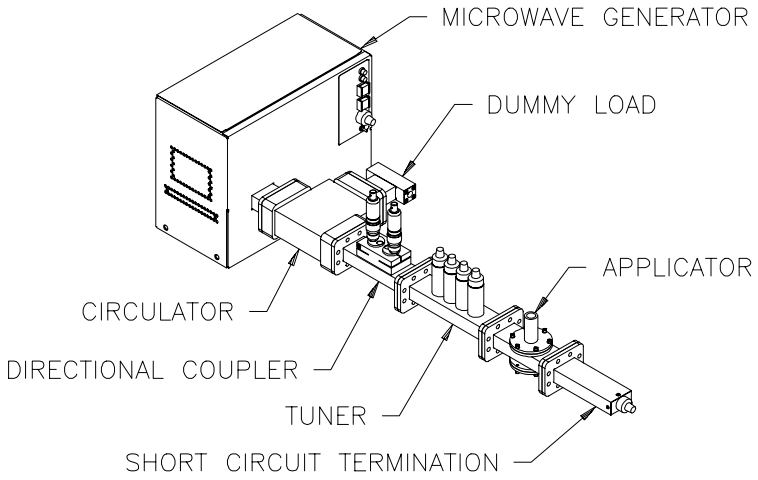

Figure 1 – Typical waveguide configuration for process heating.

Flange Connections

The waveguide flanges of the magnetron head must be properly connected to another waveguide component or series of components that provide an adequate load for the microwave power being generated. Bolts and nuts must be installed at all flange bolt holes prior to operation.

Microwave Leakage – Regulatory limits for microwave leakage relate to standards for human safety and interference with other electronic devices. Standards for human safety as adopted by OSHA, the International Electrotechnical Commission (IEC) and other regulatory agencies limit leakage to 5 mW/cm^2 measured at 5 cm from the leakage source under normal operating conditions, and 10 mW/cm^2 at 5 cm from the source under abnormal operating conditions. The U.S. Federal Communications Commission (FCC) has established regulations limiting the emission of energy at frequencies outside the ISM bands. All GAE waveguide components meets these requirements when properly connected to another waveguide component.

Interconnect Cables

All electrical power required for operation of the magnetron head is provided by the power supply through a cable harness delivered with the system. Table 1 below lists the cable interconnections between the magnetron head and power supply.

WARNING: *Failure to provide an adequate ground connection between the magnetron head and power supply chassis can expose the operator to high voltage and result in severe injury or death.*

Table 1 – Cable harness interconnections.			
Function	Conductors	Mating Connectors	
		Power Supply	Magnetron Head
Filament/Fan Power	3	TB1 (5-contact)	J2
Control I/O	8 (+ ground)	TB2 (10-contact)	J3
Ground	1	Ground Stud	Ground Stud

Line Power Connections

Connections for line power are made to the 5-contact terminal block located on the end panel of the power supply. This terminal block is part of the interconnect cable harness described above. The functions and electrical specifications of these connections are detailed as follows (refer also to the Schematic Diagram in the previous section).

Pin 1 – *Line Power Input, Neutral Phase,* connection for one phase of nominal 230 VAC. When using "Delta-connected" line power, either phase can be connected to this pin. When using "Wye-connected" line power, the *neutral* phase must be connected to this pin.

Pin 2 – *Line Power Input, Hot Phase,* connection for one phase of nominal 230 VAC. When using "Delta-connected" line power, either phase can be connected to this pin. When using "Wye-connected" line power, the *hot* phase must be connected to this pin.

Pin 3 – *Chassis Ground*

CAUTION: *The user must provide an external line power circuit protection device such as a fused disconnect or circuit breaker rated no more than 15A. The line power connection wire must be rated no less than the rating of the circuit protection device. Failure to provide proper circuit protection may result in permanent damage to the system.*

Remote Control Connections

All connections for remote control of the magnetron power supply and magnetron head are made to connector J4. Figure 2 below is a diagram of a recommended electrical circuit configuration. While other configurations are possible, the following interface requirements must be met for safe and reliable operation.

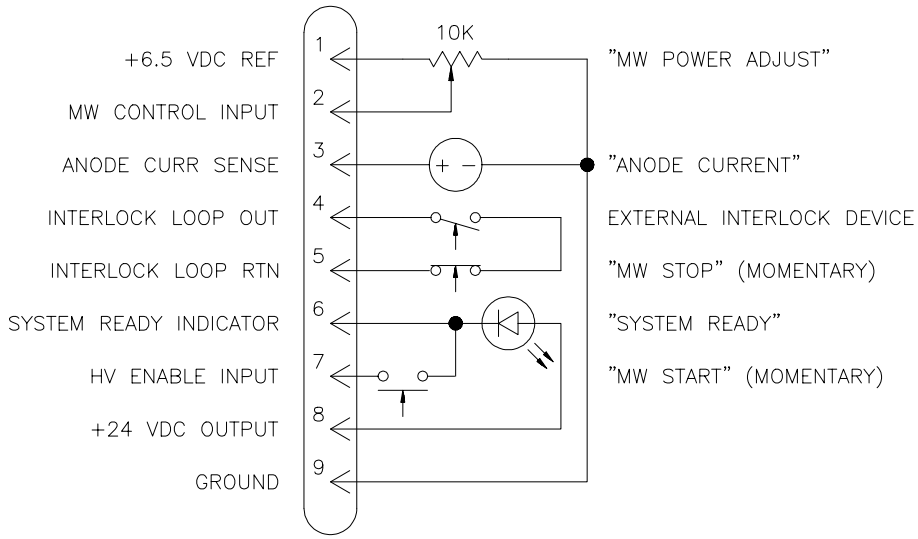

Figure 2 – Recommended electrical circuit for remote control.

Pin 1 – +6.5 VDC Reference

This is a DC voltage generated by the magnetron power supply for use by a remote power control potentiometer for the control input voltage (see Pin 2 below). The maximum allowable current draw from this source is 10 mA. Because of this current limitation, and for maximum operational stability, this voltage should not be used for any other purpose.

Pin 2 – Microwave control voltage input (0-6.5 VDC)

The level of microwave power delivered from the magnetron head is controlled by varying the voltage present at this pin from 0 to +6.5 VDC. The use of a precision multi-turn, 10K Ohm potentiometer rated for ½ Watt is recommended for high control resolution and stability. The voltage provided at Pin 1 (see above) may be used as a reference, or a separate voltage source referenced to the same ground point can also be used. The toggle switch on the front panel of the magnetron head must be set to “Remote” for this voltage to have effect.

CAUTION: *The maximum allowable input voltage for microwave power control is +6.5 VDC. Permanent damage to system can result if the input voltage exceeds this value.*

Pin 3 – Anode current sense output (1 V = 100 mA)

This signal is generated by the magnetron power supply and is proportional to the magnetron anode current. It is proportional to magnetron output power and thus can used

as an indication of microwave power generated by the magnetron head. The recommended minimum load impedance for voltage measuring devices is 250 Ohms.

Pin 4 – Interlock loop output (24 VAC)
This signal is present when all internal interlocks of the magnetron power supply are satisfied and the "Mw Stop" switch on the front panel of the magnetron head is not being pressed. This signal must be present for operation of the magnetron head and microwave power generation.

Pin 5 – Interlock loop return (24 VAC)
The voltage present at pin 4 must be returned through pin 5 before microwave power can be started. A dry contact interlock device and/or remote "Mw Stop" switch (momentary, normally closed) may be connected in series between pins 4 and 5. Opening either of these two devices will turn off microwave power.

NOTE: *Connection between pins 4 and 5 is required for operation of the GA4306 even if remote control will not be used. A jumper wire is factory-installed in the mating connector provided with the system.*

Pin 6 – "System Ready" Indicator (Ground)
This pin is connected to ground whenever the system is in the "Standby" or "Operate" mode, indicating all interlocks are satisfied and the system is operating normally.

Pin 7 – High voltage enable input (Ground)
Connecting pin 6 to ground will enable the magnetron power supply to deliver high voltage to the magnetron head. Microwave power will then be generated according to the setting of the microwave power control potentiometer(s). The recommended device for making this connection is a momentary, normally open pushbutton switch. When the system is in "Standby" mode, this pin is referenced to +24 VDC by internal circuitry.

WARNING: *Serious injury and/or death can result from the use of a non-momentary switching device for enabling high voltage and microwave power. The use of a latching device can allow high voltage to be enabled inadvertently and unknowingly, such as can happen upon resetting an interlock device. It is strongly recommended that a momentary switching device be used for the high voltage enable function.*

Pin 8 – +24 VDC Power Supply Output
This pin is connected internally to +24 VDC which may be

used for purposes of supplying power to remote control devices such as relays and indicators. The maximum allowable current draw is 200 mA. This voltage is referenced to ground.

Pin 9 – Chassis ground

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OPERATION

Basic Operation

The operating status of the GA4306 system is indicated by the LED indicators located on the top panel of the power supply and the front panel of the magnetron head. The functions of each indicator on the power supply are as follows:

POWER ON (green)	Off: Line power is disconnected. On: Line power within the rated voltage range is connected.
OVERVOLT (red)	Off: No alarm condition On: Anode voltage exceeded 5kV for more than 0.4 ms. System must be reset before operation can continue (see below).
LEAKAGE (red)	Off: No alarm condition On: Leakage current caused the anode voltage to drop below 2kV for more than 0.4 ms. System must be reset before operation can continue (see below).
RACK OVERTEMP (red)	Off: No alarm condition On: Internal temperature of power supply has exceeded safe limits. System must be reset before operation can continue (see below).
TUBE OVERTEMP (red)	Off: No alarm condition On: One or more of the magnetron head interlock devices faulted. System must be reset before operation can continue (see below).
ENABLE (blue)	Off: High voltage is off On: High voltage is on and microwave power is being generated at the level determined by the *Analog Reference Input* signal.
INTERLOCK (green)	Off: External interlock device(s) open On: External interlock device(s) closed

After connecting line power, the presence of line power is indicated on the power supply when the green “Power On” LED is on. When all of the interlock conditions are satisfied the “Interlock” LED on the power supply and the “System Ready” indicator on the magnetron

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head will then be on. The system is now in the “Standby” mode of operation.

Microwave power may now be “enabled” by pressing the “Microwave Start” pushbutton switch on the magnetron head (or by applying the remote control *HV Enable* input signal) which places the system into “Operate” mode. The generator will now deliver microwave power at a level according to the setting of the “Microwave Power Adjust” potentiometer or the remote microwave control input signal (see next subsection).

Pressing the “Microwave Stop” pushbutton switch on the magnetron head will immediately disable high voltage and turn of microwave power. The system will then be in “Standby” mode and ready to be enabled for microwave power again.

Similarly, opening any of the external interlock devices (or remote “Stop” switch) will turn off high voltage and microwave power. However, this will cause a system fault as indicated by turning off the “Interlock” LED indicator on the power supply and the “System Ready” indicator on the magnetron head. Upon closing the external interlock devices (or remote “Stop” switch) the system will return to “Standby” mode as indicated by the “Interlock” and “System Ready” indicators.

Microwave Power Control

The level of microwave output power can be controlled either locally or remotely. Local control is by the 10-turn dial on the magnetron head front panel, and remote control is by the microwave control input signal (see previous subsection on Remote Control). Only one control is active at any time and is selected by the toggle switch located below the front panel control dial.

Alarm Fault Reset

A permanent alarm fault condition exists whenever any one of the four red LED indicators is on. This condition will also be indicated by open alarm relay contacts (terminal block pins 13 and 14) and turning off the “System Ready” status indicators. To reset the system, set the “Microwave Power Adjust” dial to zero (or, if used, the remote “Microwave Control Input” signal to 0 Volts).

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MAINTENANCE AND CALIBRATION

The GA4306 microwave generator system is designed to be maintenance free with the exception of magnetron replacement. The magnetron, GAE part number 911405, is considered a consumable component and has a life expectancy that depends on operating conditions and usage. No calibration is necessary.

Although the magnetron head is a very rugged and stable device, it can be subject to damage due to improper operating conditions or mishandling. If damage occurs other than to the magnetron itself, the magnetron head should be returned to GAE for repair. Contact GAE for information on repair services.

Magnetron Removal and Installation

Removal and replacement of the magnetron can be performed by the user as follows (see Figure 3):

1. Turn off the magnetron power supply and disconnect all electrical connections from the magnetron head.
2. Unscrew the four captive cover screws and remove the access cover.
3. Disconnect the wire leads to the magnetron filament terminals and thermal cut-out.
4. Loosen the two captive screws on each of two cooling air ducts (one on each side of the duct) and carefully lift the ducts past the magnetron and out of the enclosure.
5. Loosen the four captive screws (two on each side of the magnetron) securing the magnetron to the chassis and carefully lift out the magnetron.
6. Install the new magnetron in the reverse order of removal.

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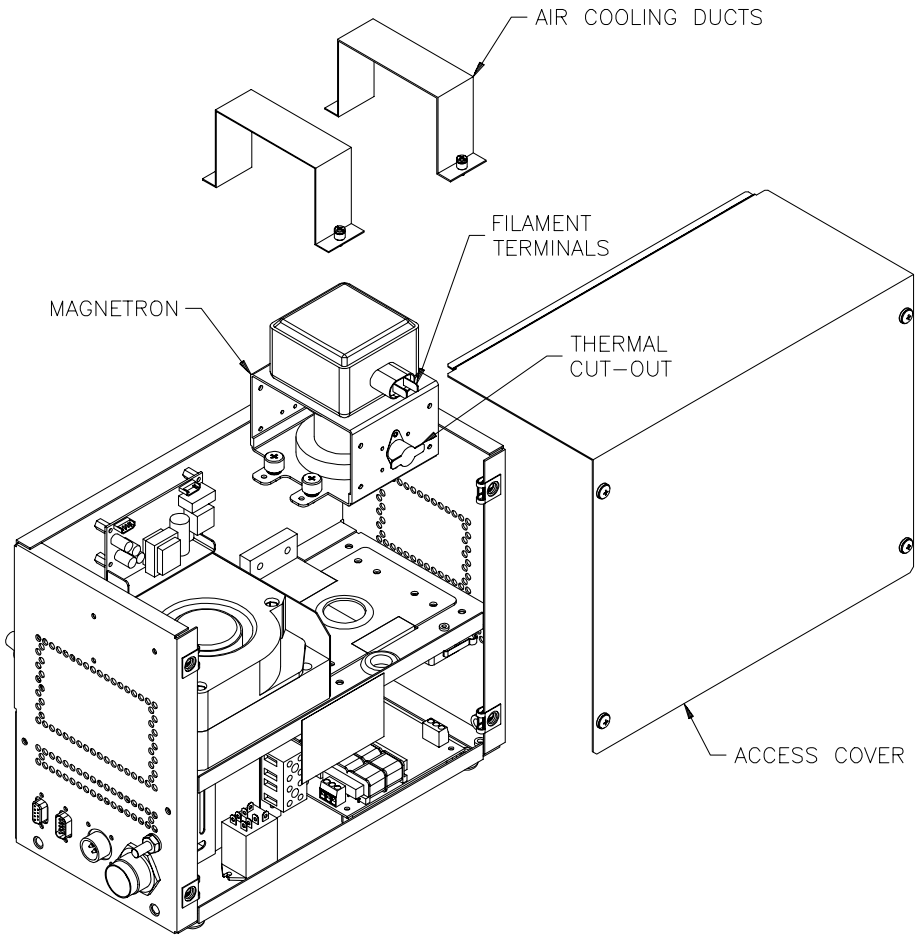

Figure 3 – Exploded view of GA4007 Magnetron Head (part of GA4306 microwave generator system) showing magnetron installation.